Exploring interpretations of blockchain's value in healthcare

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Exploring interpretations of blockchain's value in healthcare: a multi-stakeholder approach[1]

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Abstract

Purpose – Drawing broadly from the technology frame (Davidson, 2002) and organizing vision perspectives (Swanson and Ramiller, 1997) which consider the business value of information technology as resulting from actors' efforts to make sense of new technology, the study applies Ojala's (2016) business model framework to examine how different sets of actors understand the value of blockchain within the healthcare sector.

Design/methodology/approach – To include the perspective of different sets of actors, the research combines a systematic literature review to capture academic research, semi-structured interviews with blockchain experts, with an analysis of blockchain healthcare vendors.

Findings – The study finds a high degree of congruence between the perspective of different actors, with key sources of blockchain value concentrated around value proposition, particularly enhancing privacy and security; value capture, specifically cost savings, and value network, mostly enhancing data accessibility and reducing intermediation. Value delivery is the least emphasized value creation mechanism and concerns primarily improvements in supply chain transparency. Minor variations between actors' interpretations of value exist, mostly around the contribution of blockchain to support the value proposition and include the provision of social value, the creation of trust, supporting automation, and improving employment.

[1] This is the authors' manuscript version of a paper accepted for publication in Information Technology & People

Originality/value – Recognizing that the value of new technology is as much the result of actors' interpretations, as the objective outcome of its deployment, this study takes a multi-stakeholder perspective to examine blockchain's business value and highlights new aspects of value associated with blockchain deployments. The findings include a value outcome framework that allows systematic comparisons between blockchain implementations across contexts.

1. Introduction

Barely 10 years old, blockchain, a new technology that emerged in 2008 to support Bitcoin, a digital cryptocurrency, promises to fundamentally change how organizations manage their contracts, transactions and records, and in doing so to create new ways for organizations to generate value for customers and capture back some of that value (Iansiti and Lakhani, 2017). A critical question to understand blockchain potential is thus: how do different actors make sense of this new technology and its value potential, while its key features and functionalities are still being developed? This study explores this question by investigating how three sets of key actors: academics, experts and vendors, understand the potential of blockchain technology to alter the value creation and capture ability of organisations within a particular sector: healthcare.

Blockchain is a distributed ledger of economic transactions which is both transparent and, in principle, incorruptible (Tapscott and Tapscott, 2016). A growing body of work explores blockchain's potential to change how organizations create and capture value (Tapscott and Tapscott, 2016) in a variety of contexts, starting first applications in the financial services sector (Buehler et al., 2015, Beck and Müller-Bloch, 2017, Taylor, 2015) and then rapidly moving into the supply chain (Kim and Laskowski, 2018), the third sector (Kewell et al., 2017) and healthcare (Mettler, 2016).

Such research tends to describe specific blockchain deployments which are claimed to create value by improving existing processes, such as Nasdaq's plan to leverage blockchain technology to enhance its equity management capabilities (Pilkington, 2016), and by enabling new forms of transactions, such as the blockchain for good applications described in Kewell (2017). More recent research tends to emphasize the potential disruptive implications of blockchain, including supporting entirely new types of business models (Morkunas et al., 2019), enabling new forms of governance (Beck et al, 2018), and generating new forms of economic institutions (Allen et al., 2020). Such studies suggest blockchain may be creating value not only by improving existing business processes, but by radically changing how business works. There is however little effort to systematically explore the bases behind these value claims, and even less effort to consider whether different actors within the blockchain community may hold different value expectations. Faced with new technology, people form expectations about what the new technology entails, what value it provides and how it may change existing practices (Orlikowski and Gash, 1994). These expectations are critical, as they influence actors' actions in the real world (Davidson and Pai, 2004, Orlikowski and Gash, 1994), playing a critical role in explaining, for example, the diffusion of a new technology, such as blockchain. With the possible exception of the financial services sector, blockchain is still in the early stages of adoption (Du et al., 2019; Queiroz and Wamba, 2019; Morkunas *et al.*, 2019), with very few commercial grade applications (Hughes *et al.*, 2019). There are thus very few studies of large-scale implementations of blockchain, meaning there is very limited evidence on the actual value of blockchain, and incomplete understanding of its overall costs and benefits (Pan *et al.*, 2020). Under these conditions, blockchain adoption is likely to be driven by the positive perceptions people have concerning its benefits, which drive investment in commercial applications and lower resistance by creating positive cultural and social attitudes to influence the transition towards blockchain applications (Hughes *et al.*, 2019). For example, research on blockchain adoption in supply chain finds the expectations of supply chain professions concerning blockchain performance (Queiroz and Wamba, 2019) and benefits (Wang et al., 2019) as the most important factor shaping its diffusion in the supply chain. Different actors may however form different expectations about a new technology, developing different visions of what the technology involves, what organizational practices it affects, and what business value it creates (Swanson and Ramiller, 1997). Congruence amongst the visions that relevant groups of actors form about a new technology explains was found to explain both its adoption and use within organizations (Olesen, 2014), and its diffusion across organizations (Currie, 2004). Therefore, understanding the degree of alignment between the value expectations of different categories of blockchain actors is important to explain the adoption and diffusion of blockchain.

To explore the congruence between the expectations of technology value within the blockchain community, the study explores the perspective of three key stakeholders: academics, experts and vendors, within a particular sector: healthcare. Healthcare industry has long been a fruitful field to study the adoption and use of new forms of information technologies (IT) (Chiasson and Davidson, 2005). Spending on healthcare represents a large share of public expenditure, ranging from 17.2% of the Gross Domestic Product in US to 5.4% in Mexico (OECD, 2017), making healthcare a key area of national economic activity. Besides its economic significance, healthcare industry is also critical due to the sensitive nature of goods and services offered (Babitsch et al., 2012). Moreover, the multitude of actors and the combination of public and private interests that characterise healthcare sectors (Currie and Guah, 2007) generate complexities that allow a more fruitful examination of how stakeholders' interpretations shape technology adoption and use (Bunduchi et al., 2019).

The paper is organized as follows: the next section discusses the business model as a framework to examine the business value of information technology (IT) and examines evidence from current blockchain research that supports the application of the framework to study blockchain. Existing research considering how different categories of actors make sense of new technology is discussed next. The methodology section describes the research design that incorporates three strands to reflect the perspective of three sets of actors: a systematic literature review, expert interviewing and an analysis of key vendors' product information. The results of these studies are presented in the findings section, and then discussed in terms of contributions to theory and practice in the discussion section. The conclusion section clarifies the limitations of the studies and future avenues of research.

2. New technology and business value: business model and blockchain

Creating business value through IT has been a major research topic in information systems research for over three decades (Schryen, 2013). Business value is generally conceptualized as an outcome of investment in and deployment of IT and concerns the efficiency and strategic impacts of technology use on organizational performance (Melville et al., 2004). Two complementary perspectives have driven most research on IT and value creation (Oh and Pinsonneault, 2007): the resource centered approach which argues that IT is a strategic resource which creates value either by itself (Brynjolfsson and Hitt, 1996) or through combination with other complementary resources (Mata et al., 1995), and the contingency perspective which argues that value is created as a result of a good fit between IT strategy and business strategy (Henderson and Venkatraman, 1999). During the last two decades, significant advancements in IT combined with pervasive digitalization have however triggered fundamental changes in how organizations conduct economic exchanges within and across their boundaries (Mendelson, 2000), and develop strategies to create value (Bharadwaj et al., 2013), and in the nature of products and services embodied in their value propositions (Nambisan, 2013, Yoo et al., 2012). These changes have highlighted the limitations of traditional strategic management theories such as resource-based view to explain the business value of IT (Bharadwaj et al., 2013, Kohli and Grover, 2008, Yoo et al., 2012), prompting researchers to suggest new approaches, such as the business model framework, as more suitable to examine the digitally enabled changes in the value creation potential of IT (Amit and Zott, 2001, Hedman and Kalling, 2003).

While many definitions of business model exist, the concept generally encapsulates the logic of how a business works (Magretta, 2002, Teece, 2010) depicting "*the content, structure and governance of transactions*" (Amit and Zott,(2001), p. 511) that allow an organization to create and capture value for all its exchange partners (Zott and Amit, 2007). The business model incorporates the overall value network within which an organisation and its activities are embedded, and on which the organisation relies on to create and deliver its value propositions to customers and to capture some of that value back (Al-Debei et al., 2008, Al-Debei and Avison, 2010, Teece, 2010, Osterwalder et al., 2005). The business model concept thus transcends the boundaries of an organisation to encompass its entire network. By considering the way in which the organisation interacts with others to create and capture value (Zott *et al.*, 2011), the business model concept has been useful to explore not only how individual organisations (Chesbrough and Rosenbloom, 2002), but also entire industries (Johnson and Suskewicz, 2009) unlock the value potential of new technologies to create and capture value.

There are many approaches to map the constituent parts of the business model (Osterwalder et al., 2005, Chesbrough, 2007, Morris et al., 2005). In an influential review of business model research, Zott *et al.* (2011) distinguish as core to the logic of business model the organisation's revenues and cost, its value proposition and the mechanisms through which value creation and capture works, i.e. its system of activities. While Zott *et al.* (2011) do not propose an overarching business model framework to add to existing research, the elements they identify as core in their review map onto Ojala's (2016) business model framework. This framework distinguishes between four components: value proposition (what value is created for stakeholders), value capture (the revenues generated and costs incurred by the organisation), and the value network and value delivery (the system of activities within and outside the organisation) (a similar although not identical distinction is made earlier by Al-Debei and Avison (2010) between value proposition, architecture, network and finance). While the value creation and capture components explain what value the organisation generates for others and for itself, the value delivery and network components explain how this value is generated through interactions within and outside the organisation (see figure 1).

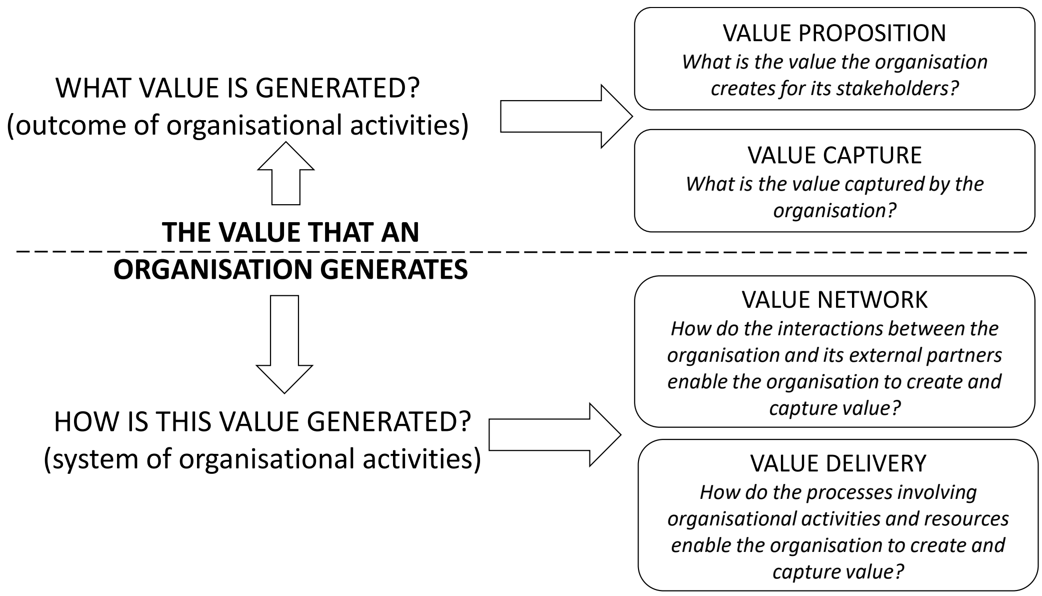


Figure 1. Four value-components framework (adapted from Ojala, 2019)

Seeing its alignment with the broad understanding in business model research (Zott *et al.*, 2011) we employ here Ojala's (2016) classification of business model components. We however depart from their approach to employ the concept to explore the impact of technology on a particular organisation. Central to the business model framework is the concept of value: how value is created and how is it captured (Zott *et al.*, 2011). While the impact of blockchain may (and will) be different on different healthcare organisations following different business models, we use the four value components as a lens to examine the way in which the application of blockchain in healthcare influences in general how value is created and captured within this sector. We are examining here the expectations that actors form about how the use of blockchain will affect *what* value the organisation generates (represented at the top in figure 1) and *how* this value is generated in the organisation (represented at the bottom in figure 1).

The **value proposition** encapsulates the relationship between the product/service an organisation offers and existing technologies (Adomavicius et al., 2008, Arthur, 2009), and the product/service's value generation mechanisms for all stakeholders (Al-Debei and Avison, 2010, Amit and Zott, 2001, Osterwalder and Pigneur, 2010, Osterwalder et al., 2005). Some recent research suggests that blockchain use may significantly alter the value proposition organisations offer to their customers by opening up new customers markets and offering them access to products and services that were previously unavailable (Morkunas et al., 2019).

However, studies examining current blockchain deployment suggest that most such changes in value proposition involve incremental improvements, such as faster service delivery, rather than radical changes. Current deployments to transform the provision of public services demonstrate how blockchain can improve the value proposition government organisations offers to their stakeholders. For example, Sweden deployed blockchain to improve land registry services, enabling a wide range of stakeholders such as traders of land, government authorities and banks to instantaneously interact and track progress of land contracts and settlements (Chavez-Dreyfuss, 2016). A similar initiative is underway in Georgia (Underwood, 2016). Other examples include the use of blockchain to speed up the recording and transaction of trade licencing, vehicle registration, marriage and birth certificates, student loans, educational certificates and government's welfare benefits (Ølnes et al., 2017).

Within healthcare, existing research finds that blockchain creates value for patients primarily through improving existing services, for example by facilitating access to patient data by facilitating the *healthcare management process* involved in granting data access permissions (Kumar, 2004), by *enhancing data privacy and security* through not only preventing unauthorized access (Kshetri, 2017) but also ensuring ownership over tamper-proof personal data (Zyskind and Nathan, 2015), and by *reducing* (although not eliminating) *the chances of counterfeiting* (Crosby et al., 2016, Engelhardt, 2017, Mackey and Nayyar, 2017, Hoy, 2017).

The **value network** depicts the key internal and external stakeholders, such as designers and R&D personnel, and customers, suppliers, investors and other partners, which engage in transactions with the organisation (Hamalainen and Ojala, 2017). The extent of the organisation's relationship with its key stakeholders explains the degree to which the organisation depends on others for generating value (Al-Debei and Avison, 2010, Osterwalder and Pigneur, 2010, Osterwalder et al., 2005, Zott et al., 2011). Existing research suggest that the most significant benefit of blockchain consists in the reduction of transaction costs (Allen et al., 2020), arguably leading to the emergence of new forms of institutions to govern exchanges amongst internal and external actors (Beck *et al.*, 2018). These institutional innovations involve radical changes in how organizations coordinate interactions with network partners, often through supporting disintermediation, and more fluid relationships amongst supply chain actors (Hughes *et al.*, 2019; Morkunas *et al.*, 2019; Wang *et al.*, 2019). Other studies emphasise the potential improvements that blockchain can bring to these interactions, mostly through improving trust between supply chain actors (Hugest *et al.*, 2019), thus encouraging better collaboration and resilience in the supply chain (Dubey *et al.*, forthcoming). Some other research draws attention to the possibly of re-intermediation rather than disintermediation, arguing that blockchain deployments increase the number of actors in the supply chain (Tonniseen and Teuteberg, 2020).

Current deployments in the financial services by diverse organisations such as Santander, Goldman Sachs, Royal Bank of Scotland, Citibank, Visa, and MasterCard demonstrate how blockchain may enact these radical changes in the nature of the relationships with the internal and external actors that form an organisation's value network. For example, blockchain brings in new internal stakeholders by enabling the connection of new intra-organisational processes, while also altering the nature of existing relationships through enabling richer integration of diverse functionalities through facilitating smooth and secure data sharing (Xu et al., 2016). Other studies highlight the incremental changes that blockchain deployment can bring to how organisations interact with their network to create and capture value. Blockchain deployments in the retailing sector for example illustrate how the technology can improve the quality of relationships with existing suppliers by, for example, facilitating detailed and accurate tracking of goods and reducing the possibility of counterfeit products (Crosby et al., 2016), although not eliminating it entirely. For example, Walmart is piloting blockchain to track the origin and movements of pork in China, while Alibaba is implementing a private blockchain network with the aim to reduce counterfeit products in its supply chain.

Within healthcare, existing studies find blockchain enables democratic *access* to patients' healthcare data (Atzori, 2015, Underwood, 2016) and empowers *patients to exercise individualized control* over their health data (Tapscott and Tapscott, 2016, Zyskind and Nathan, 2015), thus reducing intermediation. More widely, blockchain is found to *strengthen collaboration* amongst dispersed healthcare system actors (Swan, 2015), thus eliminating many of the data sharing challenges characterising the health industry (Kumar, 2004).

Value delivery explains how value is exchanged with the organisation's stakeholders (Al-Debei and Avison, 2010, Osterwalder and Pigneur, 2010, Teece, 2010), and includes the channels of distribution, the key activities and resources the organisation exploits to deliver this value (Osterwalder and Pigneur, 2010, Osterwalder et al., 2005). Thus, while value network encompasses the organisation's stakeholders and the nature of their relationship (e.g. the degree of integration, and the level of trust), value delivery concerns the processes through which the organisation transfers value to these stakeholders. These processes include the nature of activities through which this transfer takes place (e.g. how easy are these activities undertaken, their accuracy and continuity), and the resources used to support such value transfer (e.g. the use of certain technologies) (Hamalainen and Ojala, 2017).

Changes in value delivery commonly emphasised in blockchain research concern mostly improvements in existing processes related to faster, cheaper (Morkunas *et al.*, 2019) and more transparent transactions (Dubey *et al.*, forthcoming; Tonnisen and Teuteberg, 2020) facilitated by blockchain's ability to automate, streamline and increase the speed of existing processes (Hughes *et al.*, 2019; Wang *et al.*, 2019). For example, the deployment of blockchain-based "smart contracts", algorithms which automatically execute predefined actions when a set of conditions are met, are claimed to speed up business processes execution (Milani et al., 2016). Such findings suggesting incremental improvements in value delivery are replicated in empirical studies of blockchain deployments. For instance, blockchain is claimed to have significantly improved the UK welfare payment processes by making pay-outs more customizable, auditable and secure(Maupin, 2017).

In healthcare, blockchain is found to improve efficient resource management (Tapscott and Tapscott, 2016) primarily through the *automation* of data recording and validating processes (Tapscott and Tapscott, 2016, Ølnes et al., 2017), and through reducing the possibility of hacking and *preventing unauthorized access* to data (Cai and Zhu, 2016). Research also finds that blockchain implementation are generally associated with the establishment of structured data platform and wider process automation (Cai and Zhu, 2016), which lead to improvements in *transparency*, accuracy (Tapscott and Tapscott, 2016) and security (Gervais et al., 2016) of data records. Indirectly thus, blockchain deployments encourage organisations to improve the transparency, accuracy and security in their digital processes.

Value capture explains how an organisation makes money, i.e. how its products and services offered to network partners and consumers translate into financial revenue. The higher the bargaining power of its partners, the more of the revenues are passed onto them, and the less value is captured back into the organization (Zott and Amit, 2007). Some research argues that blockchain may radically change the value that the organization can capture by creating new ways of exchanging economic value among actors (Allen et al., 2020) and altering how both economic and social value is translated across different stakeholders (Elsden, 2019).

Studies of current blockchain deployments however tend to find incremental changes in value capture, rather than radical changes, involving mostly the ability of blockchain to reduce the costs and time involved in managing its business. For example, in the banking sector, the Corda platform, jointly developed by the blockchain based startup R3 and Circa, redesigned the financial settlement process and in doing so significantly reduced the time and cost involved in reconciliation between multiple actors (Brown et al., 2016). In both equity markets and insurance sectors, blockchain deployments are claimed to have reduced both settlement time and the transaction costs, while improving service quality by preventing erroneous, redundant and outdated data (Milani et al., 2016).

Existing healthcare research highlights blockchain's ability to *reduce costs and increase revenues* for healthcare providers primarily through considering the effects on improving value delivery, in particular automation and better resource management to reduce costs (Tapscott and Tapscott, 2016), and reducing the possibility of hacking to attract more clients, resulting in higher revenue (Cai and Zhu, 2016), rather than considering the direct effect of blockchain on firms' monetisation mechanisms. Blockchain is also seen to *lower audit expenditure* through facilitating compliance (Tapscott and Tapscott, 2016, Atzori, 2015), and even potentially to generate employment (Liu *et al.*, 2017).

In conclusion, the business model provides a useful framework to examine how organisations operating within a particular industry use a new technology to change what value they create and capture and how they do so (see figure 1). There is growing evidence that blockchain has the potential to influence all four components of the business model across industries, as well as specifically in healthcare.

3. Interpretations of value across multiple stakeholders: expectations, technology frames and organising visions

In the context of a new technology, where there is limited knowledge of its implementation, its value is assessed based on the expectations that actors form about that new technology, rather than on their actual experience of implementing and using the technology. It is these expectations, rather than the evaluations of realised outcomes following technology use, that shape the early stages of an emerging technology diffusion (Swanson and Ramiller, 1997) by providing structure and legitimation to the technology discourse, attracting interest and fostering investment, shaping what to expect and how to prepare, and playing a central role in mobilizing and coordinating resources to develop and adopt the new technology (Borup et al., 2006). Such expectations are important not only for the technology developers themselves, but also for other relevant group of actors including researchers, government policy, industry networks and organisations (Borup et al., 2006).

Our approach to highlight the role that actors' expectations play in shaping the pattern of technology adoption (at organisational level) and diffusion (at industry level) is congruent with socialized theoretical approaches that have been developed and/or employed by the information systems community to examine the role that individual actions and practices play in shaping the adoption and use of IT in organisations. Actor network theory (Latour, 1987), social construction of technology (Pinch and Bijker, 1984) and social shaping of technology

(Williams and Edge, 1996), structuration theory (Giddens, 1984), technology frames (Orlikowski and Gash, 1994) and organizing vision (Swanson and Ramiller, 1997), and more recently sociomateriality (Orlikowski and Scott, 2008) are examples of such approaches. They all draw the attention to the role that the social – rather than the economic or technical – plays in shaping the adoption and use of new technologies, viewing technology as socially constructed through human (SCOT) and non-human (ANT) action, and examining how varied actors' interpretation, expectations, interests and conflicts shape the production (SCOT, ANT), use (structuration, practice lens, technological frames, sociomateriality) and diffusion (organizing vision) of technology.

To understand how actors form these expectations and interpretations of a new technology, and particularly in relation to the value it generates in organizations, we draw here from the technology frames perspective (Orlikowski and Gash, 1994). Technology frames perspectives recognizes that new technologies introduced within organizations are open to different interpretations, with different actors framing the technology differently depending on their interests, power, knowledge and context, as well as on the technology material features themselves (Davidson, 2002, Orlikowski and Gash, 1994). A key element of these interpretations refers to the business value of the new technology (Davidson, 2002), or more widely to the rationales for which the technology is to be adopted and the criteria for measuring success (Orlikowski and Gash, 1994, Davidson and Pai, 2004). Within a healthcare organization, for example, managers may see new technologies as means of achieving administrative goals such as more efficient allocation of resources, while medical staff may see them as ways of achieving professional goals, such as improved quality of care (Bunduchi et al., 2015). Within organizations, lack of congruence between the interpretations of relatively interdependent groups of actors (generally users, designers and managers) concerning a new technology was found to hamper its adoption and use (Davidson, 2002, Olesen, 2014).

At industry level, a related concept is organising vision, defined as the interpretations that a new technology community form concerning the organizational application of a new technology (Swanson and Ramiller, 1997). A key element of organizing vision is the "business problematic", reflecting the rationale for IT adoption, i.e. the value that user organizations extract through its use (Swanson and Ramiller, 1997). The organizing vision plays a critical role in interpreting the emerging technology in terms of its application to solve particular business problems, legitimizing the technology within a particular community, and mobilizing resources to generate interest and support its diffusion (Swanson and Ramiller, 1997, Kaganer et al., 2010). At an industry level, the relevant groups of actors involved in the interpretation of a new technology and the emergence of its organizing vision are more loosely connected than it is the case when considering technological frames within organizations. For example Currie (2004) examines the role that the lack of congruence between the visions developed by vendors, industry analysists and academic institutions played in explaining the failure of a new technology to diffuse across the software industry, while in healthcare Greenhalgh *et al.* (2012) documents the different interpretations developed by policy makers, technology vendors, researchers and academic institutions, clinicians and management consultants which hampered the adoption of telehealth. At industry level, congruence thus matters between the visions of actors loosely connected within communities of practice (Swanson and Ramiller, 1997). Community of practices are defined here as a set of actors with interests in a common technology, and whose members include vendors and users, industry associations, research and consultancy firms and regulatory agencies (Wang and Swanson, 2007). How these loosely connected actors interpret an emerging technology reflects their interests, for example, powerful vendors seek to develop new technology-enabled products, analysts work to generate hype to further their own business opportunities, and academic institutions develop new courses to attract students and to be seen to keep up-to-date with the latest trends (Currie, 2004).

While different interpretations concerning the applications of an emerging technology are common during its early stages and not necessarily harmful to its later adoption (Swanson and Ramiller, 1997), when such interpretations are too varied and thus not easily understood by loosely coupled members of the community, too conflicting and thus sending mixed messages to users concerning the benefits of the technology, and bear little resemblance to the reality, the adoption of the new technology becomes problematic (Currie, 2004). Persistent different interpretations of the same technology between actors, even when such actors are loosely connected, affect its legitimation within the community, and hamper the mobilization of resources to support its development (Wang and Swanson, 2007). Empirical studies found that inconsistent visions of an emergent technology between such loosely coupled community actors explained why a new technology failed to diffuse (Currie, 2004, Greenhalgh et al., 2012, Swanson and Ramiller, 1997). Such inconsistent visions is a particular problem within the healthcare domain, where the groups involved have various commercial, political, professional and institutional allegiances, place different values on the use of technologies, and combine interests aligned with professional norms for clinical quality with conflicting managerial demands for efficiency (Currie and Guah, 2007, Greenhalgh et al., 2012). In this domain, existing evidence suggests that achieving coherence between multiple interpretations is particularly difficult, with emerging technologies often struggling to achieve consistency (Greenhalgh et al., 2012).

In conclusion, the technology frames / organising vision perspective informs our analysis of blockchain value by highlighting that (1) in the nascent stages of a technology, expectations of technology value inform actors' likelihood to adopt a technology; (2) there is rarely one single interpretation of a new technology in general, its business value in particular, as multiple actors construct multiple interpretations depending on their interests; and (3) understanding the degree of coherence amongst these multiple interpretations is important as it shapes the diffusion patterns of that technology within an industry. To analyse the value of blockchain, we thus complement the business model framework with insights from the organising vision perspective by examining the degree of congruence amongst the expectations of three categories of key actors concerning the ways in which blockchain affects the four value dimensions (as per figure 1).

4. Research Methodology

The research methodology combines three sources of data to examine different stakeholders' value expectations. (1) A systematic literature review of published academic research concerning blockchain deployment in healthcare captures the academic audience's perspective. (2) Semi-structured interviews with members of the blockchain community recognized as experts in the field capture the perspective of blockchain experts. These experts include researchers and academics, technology vendors and developers, consultants and representative of standardization organizations who play a significant role in shaping the discourse within the blockchain field, for example, through acting as keynote speakers at key professional conferences, representing of key professional associations in the field, or being recognized as critical actors connecting developers and users in the field. (3) A database of firms developing blockchain products in the healthcare space which captures vendors' expectations. These three categories are not entirely mutually exclusive. A particular individual may have published research on blockchain, may be a recognized expert within the community participating in key conferences and events, and could be employed by a technology vendor. In aggregate, however, academics, experts and vendors play distinct roles in shaping the discourse within an emerging community (see Currie, 2004). Our approach to include vendors, experts and academics, but not other actors such as healthcare providers, patients and regulators is due to the complexity and nascent stage of blockchain technology. At the time of our study, blockchain was (and still is) in a nascent stage, with few commercial, large-scale implementations (Hughes *et al.*, 2019), and characterised by high degree of technical complexity that obscures the potential of the technology to potential users (Du *et al.*, 2019). We have thus only considered stakeholders that either had direct experience of the technology, and/or the understanding of the technology and its potential application necessary to provide an informed view.

4.1 Systematic literature review

The systematic review covered published academic literature in health research, IT and social science discipline. Its objectives were to understand and evaluate the scope of existing research; and to categorize and analyse published evidence on the development, implementation and usage reflecting academic knowledge and expectations concerning the value of blockchain in healthcare. The review followed (Kitchenham, 2004) structured guidelines, which includes five stages: identification of research, selection of studies, quality assessment, data extraction and data analysis.

3.1.1 Identification of research

A pilot search was conducted in early June, 2018 in IEEE database to identify the keywords that yielded more comprehensive search results. The pilot involved a few iterations to refine the search query resulting in the final search query included below.

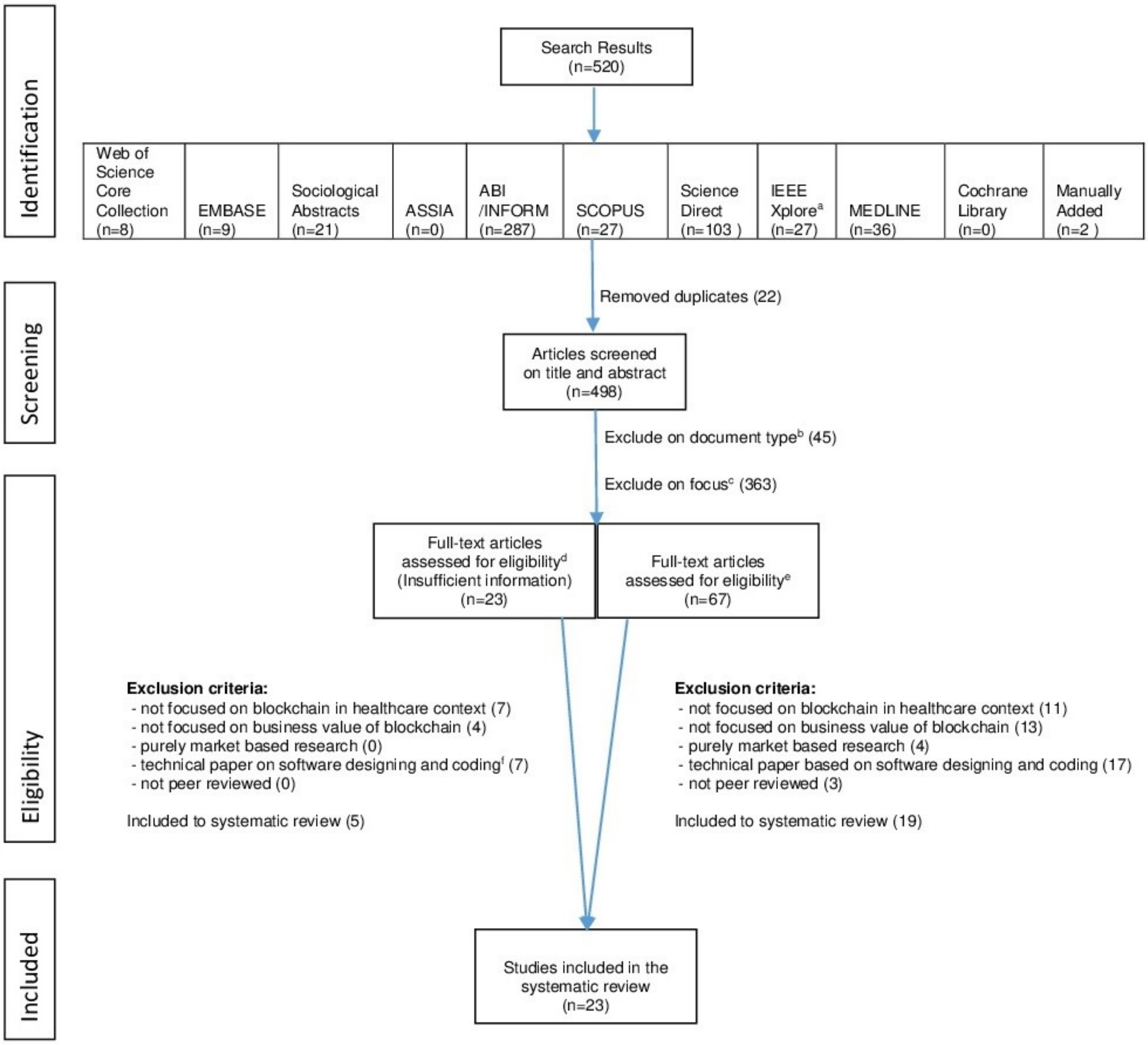
Table 1. Search query: free field-format

(Health OR Healthcare OR Hospital* OR Clinic* OR Medic*) AND ("blockchain*" OR "block chain*" OR "blockchain technology*" OR "blockchain technique*" OR "blockchain framework*" OR "blockchain security*" OR "blockchain application*" OR "blockchain application*" OR "blockchain use*" OR "blockchain ledger*" OR "blockchain protocol*" OR "digital ledger*" OR "distributed ledger*" OR "decentralized ledger*" OR "digitized ledger*" OR "secure ledger*" OR "public ledger*" OR "distributed database*" OR "decentralized database*" OR "digital database*" OR "digitized database*" OR "secure database*" OR "sequential database*" OR "public database*" OR "distributed network*" OR "decentralized network*" OR "secured network*" OR "chainbook*" OR "chained ledger*" OR "chained database*" OR "chained network*" OR "verifiable ledger*" OR "verifiable database*" OR “verifiable network*" OR “hashed ledger*" OR "hashed database*" OR “hashed network*" OR “encrypted ledger*" OR "encrypted database*" OR “encrypted network*" OR "merkle tree*" OR "satoshi*" OR "nakamoto*" OR "satoshi nakamoto*" OR "peer to peer database*" OR "p2p database*" OR "blockchain implementation*" OR "blockchain challenge*" OR "cryptocurrency*" OR "cryptography*" OR "encryption*" OR "ethereum*" OR "ICO*" OR "mining*" OR "node*" OR "private key*" OR "smart contracts*" OR "token*" OR "block*" OR "blocks*")

The search query was applied in the last week of June, 2018 to 10 online databases including studies related to health/medical sector studies: (EMBASE, MEDLINE, Cochrane Library); IT (IEEE Explore); social science (ASSIA, Sociological Abstracts, ABI/INFORM); and multidisciplinary research (ScienceDirect, Scopus, Web of Science Core Collection). The MEDLINE database required a different form of search query (see Appendix 1). To capture relevant studies not included in these databases, two further searches were conducted, one using google scholar to find relevant academic thesis papers and working papers, and another hand search of qualifying studies' references. The expert interviewing conducted in parallel was also used to identify suggestions regarding further research paper and concept notes. The initial search criteria did not include any language and publication year restrictions.

3.1.2 Selection of studies

The search results (titles, abstracts and later full text) were screened for relevance, in terms of whether they concern blockchain applications deployed within healthcare. The *inclusion criteria* were that the article should (1) be relevant to blockchain and healthcare sector; (2) have a formal or semi-formal research approach (3) evaluate blockchain's adoption or usage or both in healthcare context. The *exclusion criteria* concerned articles that were (1) not focused on blockchain in healthcare context; (2) purely market-based research; (3) technical paper based on software designing and coding; (4) not focused on business value of blockchain; (5) not peer-reviewed. The PRISMA flow diagram below details the filtering procedure in each stage of screening, the inclusion and exclusion criteria, and the number of results.



Notes: (a) Database has limitations on the number of keywords and, therefore, the search had to be run several times to ensure that all search query keywords were included. (b) Book reviews, front and back covers, copyright notice, title pages, collection of conference proceedings' descriptions, tables of contents, press releases, announcements, descriptions of issues, advertisements, bulletins, questionnaires, notices of retraction, chair's messages, keynotes, plenary talks, welcome messages, news published in journals and magazines that have "news" in their title; news published by companies that do not provide any analytical or research materials and/or presentation description; analytical materials published in newspapers, magazines, company profiles, advertising/marketing articles. (c) Articles not related to blockchain in healthcare industry and research on blockchain in healthcare industry that do not refer to blockchain's business value. (d) Articles where no abstract was available or where title and abstract did not give sufficient detail to judge eligibility; articles on blockchain that do not specify the research focus and/or industry orientation. (e) Potentially relevant articles referring to blockchain in healthcare industry. (f) Articles focused on computer science models (e.g. software specification) or coding for creating algorithms.

Figure 2. PRISMA flow diagram

3.1.3 Quality assessment

The "Critical Appraisal Skills Programme" checklist was adapted for assessing the quality of the eligible articles (CASP, 2013). To document lack of clarity in the articles regarding any specific checklist item, an extra option entitled as "not clear" was added to the default options ("yes" and "no").

3.1.4 Data extraction

The data extracted included author(s), year of publication, country of research, income group, journal's discipline, healthcare area, research design, research questions/objectives, conceptual or theoretical basis, the value of blockchain adoption, and major findings. Appendices 2-5 provide key information about selected studies.

4.2 Blockchain expert interviewing

Expert interviewing was used to capture the perspectives of blockchain technology experts. Respondents were selected based on potential respondents' experience, understanding and contribution to the blockchain field. Blockchain technology experts were identified through hand searching individuals from panel discussants in conferences (e.g. Blockchain Summit Conference, World Blockchain Technology Forum, Blockchain World Conference, University of Edinburgh Business School and Chartered Banker Institute conference), news reports (e.g. The Telegraph, CoinDesk, CCN, CNBC, TechCrunch, Bloomberg, VentureBeat, Los Angeles Times), technology magazines (e.g. Blockchain Magazine, Bitcoin Magazine), technology companies' website (e.g. IBM, Softbank, SAP, Samsung, BP, Maersk), blockchain consultancy firms (e.g. Applied Blockchain, Parity Technologies, Intellectsoft Blockchain Lab, Kwôri, Cryptonomy) and LinkedIn profiles. The search was conducted in June 2018 and identified 55 individuals that had their email address available. All were emailed to seek their participation in the study. 13 experts responded, and 12 agreed to take part. Semi-structured interviews were conducted during July 2018 through phone and lasted between 25 minutes to 1 hour. The interviews were recorded and transcribed.

Table 2: Expert respondents

Respondent's role	Company	Position
Intermediaries	Small specialized vendor	Co-founder and CIO
Intermediaries	Small specialized vendor	Advisor

IT Expert	Association for Information Systems	Academic member
Researcher	Research intensive university	Assistant Professor of Management Information Systems
Standardization bodies	Association for Information Systems	President (country chapter)
Intermediaries	Small specialized vendor	CEO
Standardization bodies	Association for Information Systems	Secretary (country chapter)
Researcher	Research intensive university	Professor and Chair of Design Informatics
Consultant	Large generic technology vendor	Business development consultant
IT Expert	Small specialized vendor	Senior support analyst
Consultant	Large generic technology vendor	Business development consultant
Vendor	Small specialized vendor	CEO

4.3 Vendors database

A database containing the key blockchain vendors in the healthcare sector and detailing the nature of their products was constructed to examine the vendors' perceptions concerning the business value that healthcare organisation may derive from deploying blockchain. Blockchain business vendors were identified from the vendors cited in blockchain based news reports (e.g. CoinDesk, Mashable, GlobalCoinReport), award winners of key blockchain events (e.g. The Blocks, MoneyToken, Smart Dubai Blockchain Challenge), and the list of top blockchain vendors in healthcare published by technology related websites and magazines (e.g. Medical Futurist, Beckers Hospital Review, CB insights). Four criteria were used to select vendors: (1) featured in at least one of these sources (2) offered healthcare products/services based on blockchain, (3) had a full-fledged website, and (4) their website contained detailed description of the company and its products/services offerings. The search was conducted throughout June/July 2018. Table 3 presents the details of the 20 vendors identified, including 17 start-up firms and 3 incumbents.

All vendors include a dedicated website describing their products and services, customer base, advisory board, different departments, contact details, and an explanation of their activities and motivation behind their existence in relation to providing blockchain solutions in healthcare.

Table 3: Details of the selected vendors

Vendor's name	Business tvpe	Technology base	Website
Zenome	Start-up	Blockchain	https://zenome.io/
Dentacoin	Start-up	Blockchain	https://dentacoin.com/
MedRec	Start-up	Blockchain	https://medrec.media.mit.edu
Embleema	Start-up	Blockchain	https://www.embleema.com
Chanqe Healthcare	Start-up	Blockchain	https://www.chanqehealthcare.com
Clinisent	Start-up	Blockchain	http://clinisent.com/
Solve.Care	Start-up	Blockchain	https://solve.care/?l=en
WELL	Incumbent	Blockchain	https://www.ioinwell.io/
Pokitdok	Start-up	Blockchain	https://pokitdok.com
Nebula Genomics	Start-up	Blockchain	https://www.nebulaqenomics.io/
SimplyVital Health	Start-up	Blockchain	https://www.simplvvitalhealth.com
Outcomes driven health	Start-up	Blockchain	https://www.odhsolutions.com/
Guardtime	Incumbent	Generic	https://auardtime.com/
Medicalchain	Start-up	Blockchain	https://medicalchain.com
HSBlox	Start-up	Blockchain	https://hsblox .com/solutions/
FarmaTrust	Start-up	Blockchain	https://farmatrust.io
FDA-IBM project	Incumbent	Generic	https://www-03.ibm.com/press/us/en/pressrelease/51394.wss
MediLedger	Start-up	Blockchain	https://www.mediledger.com
lrvo	Start-up	Blockchain	https://irvo.io/#intro
Hashed Health	Start-up	Blockchain	https://hashedhealth.com/about/

4.4 Analysis

The systematic literature review, interviews and product description data were coded using Ojala’s (2016) business model framework (see Table 4). The aim of the analysis was to identify the range of interpretations (the rows in table 4) that different categories of actors (the three columns in Table 4) develop in relation to the four value components (as per figure 1, and included in the first column in Table 4).

Table 4. The influence of blockchain on value: categories of value across the four value components and three categories of actors

Value COMPONENTS / sub-categories		Values reported related to areas of blockchain application	Value interpretations across stakeholders groups		
			ACADEMICS (studies)	EXPERTS (exemplary quotes)	VENDORS (exemplary quotes)
VALUE PROPOSITION	Privacy & security	Offering superior privacy	(Prakash, 2016) (Liu et al., 2017) (Roman-Belmonte et al., 2018) (Liang et al., 2017) (Rifi et al., 2017)	"…With this technology we get an opportunity that we can manage our digital information in a **more secure way**…"	"…This platform supports the possibility to manage your genomic data while **maintaining privacy**…" (Zenome)
		Offering personalized control	(Prakash, 2016) (Esposito et al., 2018) (Engelhardt, 2017) (Rifi et al., 2017)		
		Improving data security & integrity	(Liu et al., 2017) (Weiss et al., 2017) (Magyar, 2017) (Liang et al., 2017)		
		Enabling immutable and authorized modifications to data	(Esposito et al., 2018) (Skiba, 2017)		
		Supporting clearer data ownership	(Weiss et al., 2017) (Magyar, 2017) (Rifi et al., 2017)		
	Health data management	Facilitating data portability and sharing	(Prakash, 2016) (Patel, 2018) (Benchoufi and Ravaud, 2017) (Liang et al., 2017) (Skiba, 2017)	"…Basically, the problem that we are trying to tackle with Iryo is **reducing the friction in healthcare data exchange**…"	"…Improve health outcomes by **gathering medical records and sharing with providers** in a trustworthy manner…" (Embleema)
		Encouraging the adoption of structured data format	(Prakash, 2016) (Benchoufi and Ravaud, 2017) (Nugent et al., 2016)		
		Enhancing the prevention of unauthorized access	(Patel, 2018) (Nugent et al., 2016) (Liang et al., 2017) (Rifi et al., 2017)		
		Streamlining the process supporting medication prescriptions	(Zhang et al., 2018) (Skiba, 2017)		

	Authentic medicine and services	Supporting the reduction of counterfeit drug	(Mackey and Nayyar, 2017) (Hoy, 2017) (Engelhardt, 2017)	"…If we consider pharmaceuticals sector or medicine service, we may find that blockchain **may integrate the effort of anti-counterfeit devices to prevent the production of fake medicines** as well as to enable better detection and authentication of medicine..."	"…blockchain technology to **securely** store health records and **maintain a single version of the truth**…" (Medicalchain)
		Improving the provision of authenticity in service history	(Weiss et al., 2017) (Azaria et al., 2016)		
	Accountability in healthcare	Improving the auditability of transaction/service records	(Liu et al., 2017)	"…because the information that we derive from blockchain, these are very secured and those information are put in the chain **with much accountability**…"	"…blockchain technology **establishes accountability** and transparency in the data exchange process…" (FDA-IBM project)
		Enabling the provision of personalized health service	(Liu et al., 2017) (Wong et al., 2018)		
		Facilitating insurance claims processing	(Liu et al., 2017) (Skiba, 2017)		
	Robustness	Avoiding single point of failure	(Kuo et al., 2017) (Azaria et al., 2016)	"…It can have **more robustness** and participants will not suffer from a single point of failure…"	x
	Service quality	Improving service outcomes and deliver	x	"…an integrated blockchain among the parties, from suppliers, manufacturers to ultimate customers will confirm more secured and timely delivery of product **without compromising the quality**…"	"…enhances the provider, payer and patient experience throughout the care continuum, **driving better outcomes for each healthcare stakeholder**…" (HSBlox)
	Affordability	Reducing the cost paid by patients for service	x	x	"… aims at improving quality of dental care, **reducing treatment costs**…" (Dentacoin)
	Earnings for patients	Enabling the possibility to generate Financial rewards for patients	x	"…**tokenization** to empower individuals to share data towards solving complex and messy problems…"	" … and ability to make **a profit selling** access to different parts of the genome" (Zenome)
	Social value	Addressing a social need	x	"…you can mark the data and it allows you to complete transactions, you can then **associate a whole myriad of value to it which can range from social**, ecological, environmental,	"… MedRec is the combination of **a social need with a technological enabler**…" (MedRec)

				through medical, through history, genetic, biological, religious, faith. So yes, absolutely…”	
VALUE NETWORK	**Data accessibility**	Offering the potential for universal data access	(Prakash, 2016) (Liu et al., 2017) (Benchoufi and Ravaud, 2017) (Roman-Belmonte et al., 2018)	“…**Data sharing with different third parties** through integrated blockchain will definitely help parties from both ends…”	“…ensures a **two-way flow of diagnostic information and understanding… wider access to diagnostic and any NGS data…**” (Clinisent)
		Enabling embedded audit and confirmation	(Liu et al., 2017) (Mettler, 2016)		
		Improving the data security and integrity	(Magyar, 2017)		
		Facilitating interoperability	(Magyar, 2017)		
		Increasing the security of data exchange	(Azaria et al., 2016)		
	Avoiding intermediation	Eliminating the need for (a trusted) third party involvement	(Prakash, 2016) (Patel, 2018) (Weiss et al., 2017) (Esposito et al., 2018) (Till et al., 2017) (Rifi et al., 2017)	“…So, it is automatic. It has **no third party verification**...”	“…The Zenome project is a **decentralized** blockchain-driven database of genomic information… Zenome helps you to sell your genetic data **without involving big companies**…” (Zenome)
		Supporting decentralization in governing exchanges	(Patel, 2018) (Kuo et al., 2017) (Roman-Belmonte et al., 2018)		
	Linking network partners	Creating new possibilities for closer interactions between patients, families and healthcare stakeholders	(Prakash, 2016) (Rimpoman-Belmonte et al., 2018) (Rifi et al., 2017)	“…They can **very easily communicate with each other**. So, you can have a faster transmission and sharing of data…”	“…our API platform-as-a-service enables you to **plug directly into over 700 trading partners to access real-time transactional data at scale…**” (Pokitdok)
		Supporting integration between the systems of diverse healthcare providers	(Engelhardt, 2017)		
	Engendering trust	Create new forms of trust among partners where such trust was absent	x	“…Yes, in principle, people found some instinct to the blockchain or the cryptography connected to it that **engender trust**…”	x

VALUE DELIVERY	Transparency	Improving the tracking of pharmaceutical products across the supply chain	(Mackey and Nayyar, 2017) (Mettler, 2016)	"…you will absolutely **guarantee some more transparency** about the production, supply and delivery of drugs…"	"…**increase transparency** of the care delivery process…" (Pokitdok)
		Improving the transparency in research & production of drugs	(Mackey and Nayyar, 2017) (Borioli and Couturier, 2018) (Mettler, 2016)		
		Supporting ways to reduce some forms of fraud and corruption in health financing	(Till et al., 2017)		
		Increasing clarity in clinical trials and test reports	(Nugent et al., 2016)		
	Proper authorization	Supporting new forms of personalized authorization for data use	(Prakash, 2016) (Hoy, 2017) (Weiss et al., 2017)	"…The **authorization of individual data** will be facilitated and it will result in quick service and timely retrieval of data…"	x
		Speeding up the service due to timely retrieval of authorized data	(Prakash, 2016)		
	Automation	Enabling embedded audit and compliance reporting	(Liu et al., 2017)	"…I think the **automation aspect** of blockchain can rapidly improve that because the medical supply chain has lots of different signing walls…"	"…deploys smart contracts to **automate multi-party transactions**…**automates the referral administration process**…" (HSBlox)
		Supporting notification of billing, test results and medication events	(Liu et al., 2017)		
		Enabling the provision of telemedicine services	(Zhang et al., 2018)		
	Redistributing resources	Facilitating the redistribution of resources to avoid waste	x	"…So, it can be another way of using a trusted network to **allow the redistribution of these resources** which would mostly be thrown away which is inappropriate…"	x
VALU	**Cost savings**	Reducing errors in records and enabling automatic data updates	(Prakash, 2016) (Till et al., 2017) (Magyar, 2017)	"…in long run, when the engagement of people reaches certain threshold then, of course, it will **reduce your cost**…"	"…Dynamic medical IT infrastructure solutions drive **administrative costs down…**" (Iryo)
		Improving accuracy of resource allocation	(Borioli and Couturier, 2018)		

		Encouraging the introduction of structured data thus improving replicability of medical research	(Hoy, 2017) (Till et al., 2017) (Roman-Belmonte et al., 2018)		
		Eliminating dependence on third party for data validation	(Till et al., 2017)		
		Reducing cost and risk due to better-informed decisions by health professionals	(Nugent et al., 2016)		
		Automation of health insurance claim adjustments	(Zhang et al., 2018)		
		Seamless integration with providers existing infrastructure	(Azaria et al., 2016)		
	Reduced auditing expenditure	Improving audit compliance	(Prakash, 2016) (Kuo et al., 2017) (Esposito et al., 2018) (Engelhardt, 2017) (Azaria et al., 2016)	"…Now in blockchain, every piece of information entered is verified repeatedly, you can significantly **reduce the auditing costs**…"	"…**Compliant with ISO 27001 and relevant HIPAA legislation including CMS 2319-F…**" (Clinisent)
		Offering the possibility to create a complete and consistent medical history	(Kuo et al., 2017) (Zhang et al., 2018) (Esposito et al., 2018) (Azaria et al., 2016)		
		Preventing fraudulent transactions	(Engelhardt, 2017) (Roman-Belmonte et al., 2018)		
	Enhanced performance and return	Increasing efficiency	(Patel, 2018) (Liu et al., 2017) (Benchoufi and Ravaud, 2017) (Borioli and Couturier, 2018) (Angraal et al., 2017)	"…When you will **reduce your business process time**, you will **increase your efficiency and effectiveness**…"	"…**orchestrate episode workflows, enable visibility into and notification of episodic activities, and report required quality incentive measures**…" (HSBlox)
		Optimizing performance	(Borioli and Couturier, 2018) (Esposito et al.,		

			2018) (Angraal et al., 2017) (Magyar, 2017)		
		Facilitating the creation of a capital market for health data	(Till et al., 2017)		
	Increased revenue	Enhancing return and payment certainty	(Patel, 2018)	"…So, I can say that it can ensure payment or instalments from every ends in every stage. So it can **generate some more revenue** if you ask me…"	"…A suite of solutions for providers that want to **better engage with patients, increase collections, improve patient financial data, and optimize revenue opportunities…** practices **improve revenue cycle efficiency and optimize net patient revenue**…" (Change Healthcare)
		Enhancing brand awareness and credibility	(Borioli and Couturier, 2018)		
		Using smart contracts for multilateral and outcome-based financing	(Till et al., 2017) (Roman-Belmonte et al., 2018)		
		Integrating crypto-currencies to generate funding for research	(Roman-Belmonte et al., 2018)		
	Employment generation	Creating new jobs for health service professionals	(Liu et al., 2017)	"…it will also **increase jobs in new horizons**. Like monitoring the network, that kind of jobs will increase more. IT jobs will increase more…"	x

Coding involved a combination of inductive and deductive coding (Miles and Huberman, 1994) relying on the data to elicit interpretations that match onto our four categories, rather than fully deductive, involving solely the application of a predefined list of codes to the data. Coding was done by the first author, following agreement within the research team concerning the approach to coding, and was reviewed by the second author during regular discussion sessions to check the emerging categories against the data. To assign the codes to sub-categories and sub-categories to the broad value categories we have relied on the definition of value categories and relevant examples from blockchain discussed in Section 2. Thus, we have included all codes related to the generation of value for stakeholders, whether at individual (e.g. offering privacy and security, improving health data management, increasing service quality) or collective (e.g. social value) level. Similarly, we have included as part of value proposition all codes related to monetization (e.g. saving costs and enhanced returns). Value delivery and value network were occasionally more problematic to distinguish as sometimes changes in the nature of activities may be related to changes the nature of relationships between actors (e.g. automation of transactions may lead to closer linkages between partners). We thus coded as value network all codes that explicitly relate to relationships between the focal firms and others (e.g. improving access of data from partners, eliminating the need for a third party to act as an intermediary), and coded as value delivery all codes that reflected changes in activities where these did not necessarily involved an exchange between the firm and others (e.g. automation and transparency of processes) and those that concerned resources (e.g. redistributing resources). Where the codes were ambiguous, we resolved them through discussion between the two authors, and through examining the wider context in which that code was situated.

Following coding, the next steps involved distinguishing between categories of expectations related to each value dimension to obtain higher level categories, i.e. consider the degree of change involved, e.g. improvements or transformation in current value, and the nature of these changes, e.g. increase in volume or quality of interactions (second column in Table 5b). The final step involved calculating the relative prevalence of each sub-category within the four value dimensions across the three actor groups (columns 2-4 in Table 5a, and 4-6 in Table 5b).

Table 5A: The prevalence of blockchain's contribution to the four business value dimensions across the three perspectives - overall

Prevalence across value dimensions	Systematic literature review	Expert opinion	Company database	Average	Standard deviation
Value proposition	31%	34%	41%	35.33%	0.051
Value network	23%	23%	20%	22%	0.017
Value delivery	12%	17%	10%	13%	0.036
Value capture	34%	25%	29%	29.33%	0.045
Total	**100%**	**100%**	**100%**		

Table 5B: The prevalence of blockchain's contribution to the four business value dimensions across the three perspectives - detailed

Prevalence across value categories			Systematic literature review	Expert opinion	Company database	Average	Standard deviation
VALUE PROPOSITION (what value is generated for others)	Improving current value proposition by enhancing …	Privacy and security	38%	15%	36%	29.67%	0.127
		Health data management	31%	20%	10%	20.33%	0.105
		Authentic medicine and services	15%	15%	6%	12%	0.051
		Accountability in healthcare	12%	8%	4%	8%	0.04
		Robustness	4%	2%	0%	2%	0.02
		Service quality	0%	10%	13%	7.67%	0.068
		Affordability	0%	0%	4%	1.33%	0.023
	Creating new value propositions by generating…	Earnings for patients	0%	2%	6%	2.67%	0.03
		Social value	0%	28%	21%	16.33%	0.145
	Total		**100%**	**100%**	**100%**		

VALUE NETWORK (how value is generate through interactions with others)	Improving the ease of interaction by …	Facilitating data accessibility	37%	33%	39%	36.33%	0.03
	Changing the volume of interaction by …	Avoiding intermediation	42%	33%	22%	32.33%	0.1
	Changing the quality of interactions by …	Linking network partners	21%	15%	39%	25%	0.124
		Engendering trust	0%	19%	0%	6.33%	0.109
	Total		**100%**	**100%**	**100%**		
VALUE DELIVERY (how value is generate through processes)	Improving current processes by …	Increasing transparency	50%	50%	73%	57.67%	0.132
		Enabling better authorization	30%	20%	0%	16.67%	0.152
		Facilitating automation	20%	25%	27%	24%	0.036
	Changing existing processes by …	Redistributing resources	0%	5%	0%	1.67%	0.028
	Total		**100%**	**100%**	**100%**		
VALUE CAPTURE (what value is generated for the firm)	Improving current value by enhancing …	Cost savings	32%	38%	33%	34.33%	0.032
		Lower auditing expenditure	21%	17%	21%	19.67%	0.023
		Performance and return	29%	7%	36%	24%	0.151
		Revenue	14%	21%	10%	15%	0.055
	Creating new forms of value capture by generating …	New employment	4%	17%	0%	7%	0.088
	Total		**100%**	**100%**	**100%**		

We calculated the relative prevalence of value dimensions by calculating the percentage of mentions of a value dimension relative to the mentions of all the value dimensions within each stakeholder study. For example, within the expert study, "value proposition" was coded 40 times across all expert interviews, and all four value categories were coded in total 116 times. Thus the relative prevalence of "value position" was 34% for the expert study (40/116) (see

Appendix 8). The prevalence of value sub-categories within each value dimension was measured in a similar way by considering, in percentages, its relative number of mentions to the total number of mentions of all of the value sub-categories within that particular value dimension (see Appendix 7-9). We also tested all 26 individual prevalence scores to examine if they are significantly different from the mean with distribution of simulated scores and one-sample t-test at 95% confidence level. These findings are then discussed across the three perspectives in the next section.

5. Findings

This study explores how different healthcare actors make sense of blockchain and understand its value, while its key features and functionalities are still being developed. There are two sides to this goal: understanding the value of blockchain as perceived by members of the blockchain community, and clarifying the degree of coherence in how this value is understood across the blockchain healthcare community.

5.1 The value of blockchain in healthcare

Traditional perspectives considering the business value of new IT such as resource-based view or business process perspective emphasise the organisation as the key beneficiary of value. The business model framework instead examines the value created both for the user organisation, in this case, healthcare providers, and for their stakeholders, e.g. patients. The application of Ojala's (2016) four component framework allows the analysis to disentangle the ways in which the use of blockchain creates value by shaping both the value generated for the user organisation and other relevant stakeholders (value capture and creation components), and how this value is generated (value delivery and network components) (see figure 3).

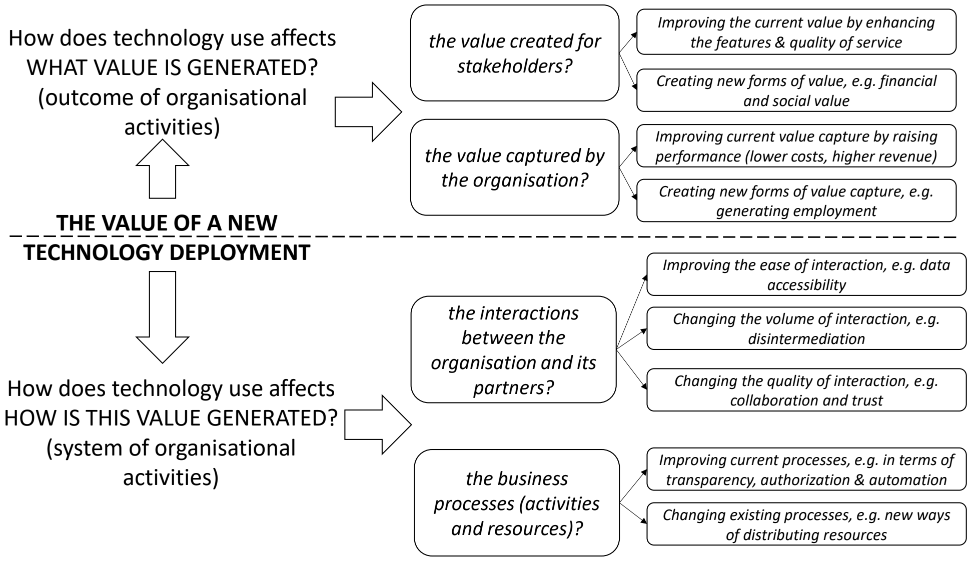


Figure 3. The value of a new technology deployment

5.1.1 Value proposition

In line with existing research, findings indicate that blockchain is expected to **improve the value proposition** of healthcare organisations primarily through enhancing privacy and security, offering more efficient management of health data, and to a lesser extent, enhancing accountability, thus offering better services to patients. These perceptions are shared across our community of actors (see Tables 5). Enhanced *privacy and security* is achieved as the use of blockchain offers customers the ability to enhance their control over their own medical records, and improve the privacy and data security, integrity and immutability, as well as the ability to identify data sharing and ownership by digital signatures. Better *health data management* is achieved through reducing friction in health data exchange, improving data tracking and verification, supporting the management of electronic health record system, enabling the reproducibility of clinical trials and disease reporting, and connecting multiple sources of data. All actors also mention blockchain's ability to enable *authentic medicine and health services* by reducing fraudulent practices through ensuring data immutability and provenance. Authenticity is highlighted primarily in the context of low-income countries where the problem of counterfeit medicine is acute. All actors also mention blockchain improves *accountability*, as the technology can support accurate insurance claim processing and auditable treatment and healthcare services, and more generally to facilitate the delivery of more accountable health services. Finally, while existing research and experts find that blockchain may improve *robustness* in data exchange as it can produce multiple data copies, and relies on many entities thus reducing the risk of failure, this view is not shared by vendors.

The findings also highlight several ways in which blockchain alters the value proposition, which are not recognised in existing research. Both vendors and experts find that blockchain improves current value proposition through (1) improving the *quality of healthcare service provision* through enabling speedy delivery of healthcare products and services, and **offers new forms of value proposition** by (2) offering the *patients the ability to earn money* through providing a platform that enables patients to sell access to their health data to healthcare researcher organisations, and by (3) enabling the delivery of *social value* through reducing fraud, encourage trust and morality, and supporting honesty and ethical behaviour in health data exchanges. Vendors are alone in suggesting that blockchain may *improve the affordability of healthcare services* through improving patients' medication adherence and thus ultimately lowering the costs of medication for patients.

5.1.2 Value network

In line with existing research, our findings show a wide agreement within the healthcare community concerning blockchain's impact on transforming the healthcare organisations' networks in three ways: improving the ease, changing the volume and altering the quality of interactions within the network. Blockchain is widely perceived to **ease interactions** amongst healthcare actors by improving *data accessibility* through enabling universal data access, embedded audit and confirmation, interoperability, and secure data exchange. Similarly, all actors recognized blockchain's ability to **alter the volume of interactions** by *reducing intermediation*. Less intermediation is linked to the decentralized and independent nature of blockchain, which is perceived to eliminate the need for trusted mediators to verify accurateness in exchanges amongst healthcare network partners. Less intermediation is widely expected to lead to cheaper, faster and more reliable health services, and leaner supply chain, and to empower patients to manage their own health data. To a lesser extent, there is agreement across the community that blockchain improves the **quality of interactions** by establishing *stronger links* among patients, families, health professionals, insurance organization and other healthcare stakeholders, while also integrating distinct health service providers through sharing health records data, and through facilitating the integration of telemedicine and biometric devices such as smartwatches and mobile phones in the healthcare system.

The findings also highlight a new way through which blockchain changes the quality of interactions within the healthcare providers' value network, although this view is not shared across the community. Experts alone argue that blockchain *improves trust* amonst nework partners through enabling faster data transmission and a decentralized database system, which is critically especially in contexts where corruption is high and trust is lacking. Such expected benefits were however not supported by existing research, nor were they claimed by vendors.

5.1.3 Value delivery

In line with existing research, creating value through value delivery was the least emphasised dimension across all three actors. By and large, blockchain is perceived to **improve existing** organisational **processes** by enabling healthcare actors to track every stage of the pharmaceutical supply chain thus enhancing *transparency in health service delivery*. Better transparency is associated with the reduction in fraud and corruption in healthcare financing, the ability to demonstrate provenance of digital data, and better clarity in clinical trials and test reports (existing research and vendors). Experts emphasise the benefits of transparency for low-income countries with corrupt administration where transparency reduces the production of counterfeit drugs, while vendors highlight the benefits of transparency in facilitating the use of patients' data for medical research by healthcare providers. To a less extent, all actors also empahsise the ability of blockchain to *automate a wide range of health service processes* which is seen to speed up and simplify health service delivery.

There is less consistency between actors' expectations related to blockchain's ability to facilitate patients to authorise the use of their health data during the delivery of health services. Enhanced authorisation of data use is perceived as a benefit only in existing research and expert interviewing, but does not come across in vendor data.

The findings also identify a new way through which blockchain is seen to **change existing processes**, through supporting the redistribution of resources enabling actors to minimizing waste in healthcare resource (experts). For example, a blockchain based medicine record where users could post the drugs they have and do not need would enable actors to re-think the way in which health resources are redistributed among users of healthcare products, not only reducing medical wastage but also enabling new types of processes to enable users to access medicine. However, this view is not shared across the community.

5.1.4 Value capture

Our analysis finds that blockchain is widely seen across the community as **improving the value that the organisation captures back** through enabling cost savings, primarily through reducing auditing costs, increasing the performance and revenue of healthcare organisations, and enabling the **creation of new forms of value capture** for the organisation through generating additional sources of employment. These expectations are shared across the community, with the exception of the latter, which is emphasised mostly by experts.

Blockchain is primarily expected to *reduce* healthcare providers' *costs* through the changes it brings in enhancing the value network (e.g. enabling better integration of diverse sources of data across the healthcare network) and delivery (e.g. enabling automation in supply chain, reducing fraud and data errors, improving accuracy of resource allocation). Most significantly, all actors emphasise blockchain contribution to *reducing healthcare providers' auditing expenditure* by enabling complete and consistent medical history, auditable transactions, and preventing fraudulent transactions through secure and time-stamped medical records. These perceptions are shared across the community. In contrast, experts alone mention that blockchain allows healthcare organisation to raise funding at lower costs through initial coin offerings, and mention the reduction in legal expenses associated with compliance with data protection and privacy rights regulations.

To a much lesser extent, blockchain is also perceived by the entire community to *increase revenues* by ensuring certainty of payments, enhancing brand awareness, creating trust which enhances customer loyalty, and by using smart contracts and crypto-currencies to generate funding. Blockchain is also expected to enhance *organizational performance* through increasing efficiency, optimizing performance, reducing business process time and maximizing resource utilization. Vendors alone mention that using blockchain to enhance value delivery (e.g. through improving doctors and researchers' access to patients' data; preventing duplication of process and providing real-time data sharing) boosts organisational performance (e.g. improves doctors' ability to conduct research but reduces data management costs; reduces time in healthcare delivery processes while improving diagnosis). While the performance-enhancing dimension is emphasised by vendors, it is downplayed by experts, who highlight instead the effects of reducing cost and increasing revenues.

Finally, experts, and to a much lower extent existing research, highlight that blockchain deployments enable organisations to capture new forms of social value through *creating new* *jobs* for health service professionals in the areas of blockchain's deployment, maintenance and quality assessment of automated health services.

5.2 Blockchain value: a multi-stakeholder approach

Existing research suggests that the expectations that a technology community forms concerning the organisational application and value of an emerging technology are critical in explaining its patterns of diffusion, at least in its early stages (Swanson and Ramiller, 1997). The findings reveal several differences in the emphasis stakeholders place on the categories of value within the four business model components, focusing on either incremental or transformational changes in value creation and capture. These differences were identified by examining the standard deviation between the relative percentages across the three actors (see Table 5). Thus, the higher the standard deviation, the higher the degree of incongruency between the actors' expectations. To check the results based on standard deviation, all individual prevalence scores are tested to examine if they fall within the desired range (95% confidence interval) in the distribution of simulated scores, prepared with the observed level of randomness. To reconfirm the finding, the individual prevalence scores are tested to examine if they are significantly different from the mean with a one-sample t-test at 95% confidence level.

Overall, the findings indicate a high degree of coherence amongst the community expectations regarding blockchain application in healthcare (the degree of incongruency varied between 0.017 and a relatively low 0.152[2], all the observed scores were within the 95% confidence interval, and the one sample t-test found that all the prevalence scores are not significantly different from the average score[3]), contrary to research examining the diffusion of other new technologies in healthcare (e.g. telehealth, (Greenhalgh et al., 2012); IT programme, (Currie

[2] The highest standard deviation possible in our case (for 0%,0%,100%) is 0.471, hence why 0.152 is considered still relatively low.
[3] The simulated distributions and t-test results are not reported due to length limitations.

and Guah, 2007)). The expectations of the three categories of stakeholders studied here converge on highlighting that the key sources of value are concentrated around value proposition and capture (whose average together counts for 64.66% of the perceptions of value), followed by value network (average of 22%), with value delivery being the least emphasized value creation mechanism (13% in average). Moreover, Tables 5 show that the most common expectations is that blockchain will improve existing forms of value, and the current approach to generate such value, rather than drastically transforming them. Expectations of value transformation represent only 19% for value proposition and 7% for value capture. Similarly, changes to current processes represent only 1.67% of expectations concerning value delivery. The only situation where expectations of transformational impact are predominant is in the case of value network, where changes in the volume and quality of interactions represent 63.67%. The deployment of blockchain is thus expected to generate value mostly by improving healthcare organizations' current ***value proposition*** through enhancing privacy and security and improving health data management; improving and transforming their ***value networks*** through enhancing data accessibility and reducing the need for intermediation; enhancing ***value delivery*** through improving transparency; and supporting existing ***value capture*** mechanisms through cost savings and reducing auditing expenditure. The overlap between the expectations, both at the level of the overall value components (the emphasis on value proposition and capture) and at the level of the value categories within these components (for example around transparency and cost savings) suggest that the community is developing a consistent message to attract blockchain users. Such convergence suggests that the community's vision concerning the application of the technology is coherently understood, with similar interpretations of how blockchain can create value for adopting healthcare organizations and their customers. Such coherence is critical to ensure the technology gains cognitive legitimacy within the community (Wang and Swanson, 2007) increasing its chances of successful diffusion (Kaganer et al., 2010).

While experts may be the most optimistic, and vendors emphasize the most immediate aspects of value, most of their expectations are substantiated by existing academic research suggesting a narrow gulf between discourse and reality. This broad fit between rhetoric and practice (as demonstrated by findings of current research on blockchain deployments) increases the credibility of vendors and experts' claims, thus legitimizing the technology and increasing the chances of successful diffusion (Kaganer et al., 2010). The ability to articulate a clear and credible message about what the value of the technology is for its adopters is likely to enhance the development and maintenance of a consistent organizing vision within and beyond its community, positively affecting its adoption and diffusion (Currie, 2004).

Nevertheless, our findings also identified variations in value expectations across the community. Existing academic research highlights fewer value categories across all four value components. Some of the areas of value proposition such as earnings for patients, service quality, affordability and social value remain entirely unexplored in existing research. Among the other value components, there is no evidence that blockchain engenders trust, redistributes resources, and generates employment within the healthcare sector. A reason behind the lack of academic focus in these areas could be that blockchain is still in an early stage, with research on healthcare applications starting from 2016 only. In addition, most published research on blockchain in healthcare are pilot studies, and thus focus on value arising from small-scale implementation. Another reason is that while experts and vendors emphasise the promissory aspects of blockchain to legitimise their investments in blockchain (van Lende, 2012), existing studies tend to focus on actual deployments, where the focus is on realised benefits, rather than potential outcomes.

Blockchain vendors' expectations stress privacy and security, social value, data accessibility, linking network partners, cost saving and enhanced performance and return. Generally, vendors seem to attempt to advertise aspects of blockchain value that they perceive is an important criterion for their clients, and/or on which their business model offers a direct and significant impact. For example, vendors put the highest emphasis (41%) on describing the value proposition and value capture (29%), thus suggesting that they are mostly interested in highlighting their new value offerings and how these offerings translate into saved costs or enhanced income. Lower costs and higher income represent direct benefits associated with the use of IT (Bunduchi and Smart, 2010) and as such are more visible to the clients. Vendors have placed comparatively less emphasis on the value network (20%) and value delivery (10%) dimension possibly because these benefits are indirect, involving improvements in process efficiencies or strategic changes in existing network relationships (Bunduchi and Smart, 2010), and are thus less visible to end users. In addition, often vendors take advantage of (and often contribute to) the market hype by aligning their offerings with what they perceive their customers need, thus seeking pragmatic and cognitive legitimacy for their offering (Kaganer et al., 2010). For example, about half of the vendors promised that their blockchain solutions will deliver social value which matches current trends towards businesses delivering social value, especially so in the healthcare space.

Overall, experts supplied the largest number of value categories across all categories, while also providing the most balanced view (the difference between their top and bottom category varies between 34%-17% comparing with 34%-12% for academic research and 41%-10% for vendors). Experts also identified a range of new value categories including creating trust, engendering employment opportunities, and redistributing healthcare resources which were supported neither by vendors' nor by current research. Why are experts the most enthusiastic and optimistic about blockchain's value? Experts often act as founders, advisors, analysts, chief executive officer, chief information officer, researcher and member of the standardization bodies related to blockchain technology, and thus have not only direct technical expertise but also direct interest in the diffusion of blockchain. It is thus not entirely unexpected that experts were the most positive in their value expectations. Variations in expectations have been attributed in previous research to differences in actors' interests (Currie, 2004), as well as to their experience with the technology and context of deployment (Orlikowski and Gash, 1994). Nevertheless, several experts did highlight the trade-offs involved in blockchainand expressed concerns about the blockchain's capability to deliver its promises.

6. Discussions

We set out this study with two research questions (1) understanding the value the blockchain creates in healthcare and (2) understanding the degree of coherence that the healthcare community forms around this new technology. Regarding the first research question, our study finds that blockchain delivers value mostly through enhancing, and to a lesser extent through transforming, all four components of the business model. The most important avenues for business value generation through blockchain include improvements in current value proposition (primarily in the form of enhanced privacy and security and health data management), and value capture (primarily through facilitating cost savings and reducing auditing expenditure). The contributions of blockchain to value network and value delivery were much less emphasised. For value network, value arose through improving data accessibility and avoiding intermediation, while for value delivery through improving transparency in supply chain. Overall, expectations across the community emphasise incremental improvements in value, rather than the radical transformation suggested in some recent research (e.g. Allen et al., 2020). Regarding the second research question, our analysis points to a high degree of coherence amongst the blockchain community members concerning their expectations for value generation, but also identifies a few areas of divergence. In the context of blockchain's value capabilities in healthcare, the biggest disagreements were noticed around the areas of social value (for value proposition), engendering trust (for value network), automation (for value delivery), and employment generation (for value capture). Most of these areas of disagreement concern areas blockchain is expected to radically transform existing value, and thus where the level of uncertainty is higher, such as creating new forms of value creation and capture and changing the quality of interactions.

The contributions of this study to existing research are twofold. First, the study contributes to research on the value of IT in organisations. Despite the insight that expectations and interpretations matter as much as the outcomes of technology deployment in shaping its adoption, use and diffusion (Kaganer et al., 2010, Swanson and Ramiller, 1997, Davidson and Pai, 2004, Orlikowski and Gash, 1994), and the realisation that digital technology requires different perspectives in examining its contribution to value creation (Amit and Zott, 2001, Bharadwaj et al., 2013, Yoo et al., 2012), research on the business value of IT continues to take an outcome-based perspective and draw from traditional perspectives to frame the investigation of value (Schryen, 2013). Drawing broadly from the technology frame (Davidson, 2002) and the aligned organizing vision (Swanson and Ramiller, 1997) perspectives, which considers the business value of IT as the result of actors' efforts to make sense of new technology, the study applies Ojala's (2016) business model framework to examine how different actors understand the value of blockchain within a particular sector. Our approach to examine the value of technology through the combined lens of the business model and organizing vision approaches has two key advantages over traditional perspectives to consider the business value. On one hand, applying a business model lens allowed the research to identify of a range of value dimensions that were ignored in previous research, particularly around non-economic and network value outcomes. For example, a key finding concerns the need to expand the understanding of blockchain's business value beyond economic dimensions to incorporate social aspects of value associated with changes in the value proposition. Similarly, the analysis reveals the potential of blockchain to engender trust between firms' stakeholders and to redistribute resources across the network in a way that improves stakeholders' ability to exchange value. Capturing such social and network value outcomes of technology deployment is difficult when relying on traditional economic and firm centric approaches to examine value which dominate current IT value research (Bharadwaj et al., 2013, Kohli and Grover, 2008, Yoo et al., 2012), such as the resource based view (Mata *et al.*, 1995) or the strategic alignment approach (Henderson and Venkatraman, 1999).

On the other hand, using the organising vision lens highlighted the need to consider a stakeholder-based approach for analysing business value especially in the context of emerging new technologies. Emerging new technologies lack a history of successful implementation, meaning that actors form expectations of value based on its potential, rather than on evidence of its implementation within user organisations (Borup et al., 2006). Moreover, multiple expectations of value associated with a new technology often emerge within its community and have been shown to shape its adoption and diffusion (Kaganer et al., 2010, Swanson and Ramiller, 1997). While research drawing from the sociology of expectations (Borup et al., 2006; van Lende, 2012), technology frames (Olesen, 2014) and organising vision (e.g. Greenhalgh et al., 2012) frameworks has widely acknowledged the importance that multiple value expectations play in shaping the trajectory of a new technology, there has been little effort in IT business value research to examine these value expectations. Instead, the focus remains solidly on examining the (expectations of) value from the perspective of the focal firm (Kohli and Grover, 2008; Melville et al., 2004). The success of a new technology is however rarely solely the preserve of adopting firms, instead relying on involvement of a wider community of loosely connected actors ranging from vendors and IT consultancy firms to research units and regulatory organisations (Currie, 2004; Wang and Swanson, 2007). Our study shows that value expectations do vary between different stakeholders involved in the adoption of a new technology, and in doing so has also identified a range of new value outcomes that were ignored in existing research, where the analysis focused exclusively on the perspective of user organisations. Our analysis thus demonstrates the need to take a stakeholder approach when examining the value of a new technology.

Second, the study contributes to research on blockchain in general, and in healthcare in particular. While existing blockchain research has been concerned with examining the value of the technology in a variety of contexts (Tapscott and Tapscott, 2016), there has been little effort to systematically explore the nature of these value outcomes, nor to consider whether such value claims vary across sectors, actors or specific applications. Current research either focuses on implementations in specific sectors (e.g. Kewell *et al.*, 2017; Kim and Laskowski, 2018), or lumps together different applications, actors and sometimes sectors in their analysis (e.g. Elsden *et al.*, 2018; Underwood, 2016). Moreover, the scarcity of large-scale implementations of blockchain (Hughes *et al.*, 2019) means that there is limited understanding of the actual value of blockchain (Pan *et al.*, 2020). Our approach offers a framework to disentangle the blockchain's value outcomes sub-categories for each of the four value components. Employing this value outcomes framework both sensitises researchers to consider both incremental and radical changes, to include under-explored value outcomes (such as value delivery, or non-economic outcomes), and enables systematic analyses of the value potential of blockchain across sectors and applications. Moreover, we show that value expectations around blockchain vary across actors, and more so for some value components than for others (e.g. value proposition). This finding highlights the need for blockchain research to take a stakeholder approach when examining value claims.

Furthermore, most current research on blockchain in healthcare focuses on the technical aspects of blockchain, e.g. Patel (2019), rather than the value creation potential of the technology. The few studies that highlight the benefits of blockchain do so in a descriptive manner, relying mostly on single case studies, e.g. Zhang et al. (2018), and often pilot implementations, e.g. Azaria et al. (2016). Much of existing studies also fall short in methodological rigour. This study thus brings two contributions to current healthcare blockchain research. First, it provides a robust and comprehensive evaluation of the value of blockchain by combining the perspective of three key members of blockchain community: academics, vendors and technology experts. Second, it points to a number of avenues through which blockchain creates value which are currently ignored, both for user organisations, for example through enhancing trust and strengthening linkages across the value network, and their patients, such as financial and social benefits.

For practitioners, understanding how blockchain may alter what value organisations generate, and how such value is generated can help them to better assess the business case for investing in blockchain. Recent research advises that practitioners should follow a pragmatic approach to assess the benefits of blockchain (Hughes *et al.*, 2019), and suggest they use the business model to examine the implications of blockchain and guide their decision to implement or not blockchain (Tonniseen and Teuteberg, 2020). We take these suggestions forward, and develop a structured framework (see Table 5b; figure 3) that delineates different sub-categories of blockchain value. This blockchain value framework can inform IT managers in user organisations when examining the business case for investment in blockchain, as well as a providing a checklist to monitor the realised outcomes from blockchain. We also find that despite the current emphasis on transformative outcomes, most current expectations focus on incremental improvements. We thus recommend that in implementing blockchain, focusing first on clarifying incremental changes in value would be more likely to match existing expectations in the community. We also highlight that different groups of actors have different expectations. To make sense of the potential of blockchain, it is important to consider the expectations concerning the benefits of blockchain not only of practitioners (Wang et al., 2019), but also of other actors that are directly involved in it is implementation (e.g. vendors as well as experts such as consultants that the organisation may employ). Whether for vendors seeking to convince users to implement blockchain, or for users seeking to decide whether blockchain creates value for their organisation, our findings suggest the need to include a wider range of actors in their evaluations of the technology value, and a more diverse range of value categories, particularly in relation to network and non-economic outcomes.

7. Conclusion

We set out to examine the value of blockchain in healthcare through the combined lens of the business model and organizing vision approaches. Based on the four business model value components, we build a blockchain value framework that identifies different categories of value outcomes associated with the deployment of blockchain. The analysis identifies a range of value outcomes ignored in existing research, and finds a high degree of congruence in the value expectations across the community. We bring several contributions both to IT value research, by demonstrating the value of the combined framework, and to blockchain research in healthcare, by developing a systematic and rigorous approach to examine the value of blockchain across different contexts.

No study is without limitations, and this research is no exception. The key downside is the inclusion of only three sets of actors: experts, vendors and academic research. Including healthcare providers and patients, as well as other stakeholders in the value chain (e.g. healthcare research, regulators), rather than relying on experts and academic research to relay their views would have strengthened the analysis. At the time of our study, blockchain diffusion was still in its nascent stages, and there was a very limited number of cases of real world blockchain implementations beyond small-scale, pilot studies (Du *et al.*, 2019; Hughes *et al.*, 2019). Moreover, the complexity of the technology makes it more difficult to understand to the non-expert audience comparing with other technological innovations in this sector (e.g. robotics or telemedicine) where the potential applications are easier to conceive. Consequently, healthcare providers are not included as a group at this stage due to their limited exposure to blockchain. Considering the early stage of blockchain deployment as well as the complexity of the technology, we have thus only selected stakeholders that had direct experience of the technology, and/or the expertise necessary to provide an informed view. As the technology becomes more accepted, the number of real world applications increase, the role of other stakeholders such as healthcare providers, patients and regulators increase in shaping shape the future diffusion pattern.

There are a few avenues for further research. First, this study was based on mostly cross-sectional data, though the systematic literature review includes some findings from past periods (but short in span). A longitudinal study would provide a more comprehensive view of changes in the interpretations of blockchain's value over time, pinpointing the evolutions in the interpretations of business value across the community across a larger timeframe. Besides the business model-based research framework, applying multiple lenses to examine blockchain's business value, such as business process view, resource-based view, strategic alignment-based view would enable the research to establish the overlaps and differences afforded by these theoretical lenses, and consider which work best for which purposes.

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